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(12) **EUROPEAN PATENT APPLICATION**

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(54) Conversion of certain hydrocarbons using silicate catalyst.

(57) By-product effluent streams from pyrolytic hydrocarbon cracking processes containing monoolefins and diolefins, are treated to hydrogenate the olefins and to aromatize the aliphatics, with a catalyst essentially comprising a silicalite molecular sieve.

EP 0 093 475 A1

CONVERSION OF CERTAIN HYDROCARBONS USING
SILICATE CATALYST

This application is related to two patent
applications filed concurrently herewith (attorney's docket
nos. Eur 1236 and Eur 1237).
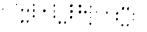
BACKGROUND OF THE INVENTION

1.　Field of the Invention

This invention relates to the preparation of streams
containing recoverable benzene, toluene, and xylenes ("BTX")
from initial by-product effluent streams that contain other com-
ponents, notably monoolefins and diolefins. In one aspect, the
invention concerns the removal by conversion of these other
components which ordinarily prevent recovery by distillation
or solvent extraction of benzene-toluene-xylenes aromatics from
the streams. In another aspect, it concerns a low severity
process for treating the by-product streams with a specified
catalyst, and under defined reaction conditions, both to pro-
duce benzene-toluene-xylenes from the initial stream and to
reduce or eliminate those components that otherwise would in-
terfere with the economic recovery of these aromatics from
the streams.

2.　Description of Prior Art

The preparation of light olefins and diolefins,
mainly ethylene, propylene, and butadiene, by the thermal
pyrolysis, or cracking, of petroleum fractions is well known
and widely practiced. (See for example, Kirk & Othmer's
"Encyclopedia of Chemical Technology", Second Edition, Vol. 8,
pp. 503-514.) In these pyrolitic cracking processes, hydro-

carbons ranging from ethane, through LPG (liquefied petroleum gas, chiefly propane with a few percent butanes), naphtha, heavy gas oil, to even crude petroleum oil, are subjected to high temperature conditions, at low pressure and for a short

5   time, to produce a maximum of the desired product. These thermal processes vary widely, and the yields from any one process depend not only on process equipment and conditions, but on such extraneous factors as the presence or absence of diluents and other reactants, e.g., oxygen, hydrogen, steam,

10   etc.

          Even the best of the pyrolitic processes is less than ideally selective. As a consequence, the total reactor effluent will contain not only the desired olefin or diolefin, but a variety of other components, ranging from methane gas to

15   high boiling polycyclic hydrocarbons. These by-products are conventionally separated, usually by distillation and/or absorption, so as to concentrate the main desired products for ultimate recovery, and to produce one or more by-product effluent streams.

20   The by-product effluents contain a mixture of hydro-carbon types, including paraffins, monoolefins, diolefins, aromatics, cyclics, and various substituted and polynuclear aromatics. Unless the by-product effluent stream or streams contains a particularly valuable or desirable component,

25   making removal economical, the by-product effluent streams are of only limited utility. The lighter gases are useful only as fuel, while the heavier, normally liquid, components usually termed "dripolene," if not hydrogenated and then subjected to BTX extraction, are customarily either burned locally as fuel

30   or else hydrogenated to saturate the unstable diolefins, and then blended with other gasoline fractions as motor fuel.

It has long been recognized that some of these by-product effluent streams, particularly the dripolene frac-tions, contain potentially valuable benzene, toluene, and xylenes (including ethylbenzene). Unfortunately, they also contain diolefins and monoolefins, which effectively inter-fere with most existing solvent extraction processes, such as the Udex and Sulfolane processes, for the extraction of aro-matics from paraffins. Some of these olefins have boiling points similar to those of the BTX aromatics, and hence cannot be removed by fractional distillation. Selective hydrogenation to saturate the olefins and diolefins is practiced, and widely so, but the process tends to be expensive. Moreover, the diolefins in dripolene tend to be thermally unstable, forming catalyst-deactivating and exchanger-fouling carbonaceous de-posits.

A variety of catalysts has been proposed for treat-ing one or more of the by-product effluents from pyrolitic cracking processes so as to render the streams more valuable or more amenable to subsequent processing. (A tabulation of representative references identifying many of these processes, and many catalysts having conceivably useful activity for these processes, is appended.)

It is an object of the present invention to provide a process for preparing a stream from which benzene-toluene-xylenes may be recovered, by catalytically treating by-product effluent streams from pyrolytic hydrocarbon cracking processes. A further object is to provide a process for treating such by-product effluent stream in a simplified, low severity, operation so as both to produce benzene-toluene-xylenes (BTX), and, simultaneously, to decrease the content of interfering components. Still another object is to remove those monoole-

fins and diolefins which have heretofore interfered with the
solvent extraction of BTX from dripolene and the like.

SUMMARY OF THE INVENTION

Briefly, in accordance with the invention, a stream
from which benzene, toluene, and xylenes may be recovered
readily is prepared by contacting a pyrolitic hydrocarbon
cracking by-product effluent stream, containing substantial
amounts of interfering monoolefins and diolefins, with a sili-
calite molecular sieve catalyst under low severity hydrocarbon
processing conditions. As a result of this treatment, not
only are the olefins hydrogenated to non-interfering aliphatics,
but a substantial fraction of the aliphatics is dehydrocyclized
to benzene-toluene-xylenes.

On of the remarkable aspects of the invention is that
the same low severity conditions of temperature, pressure, and
space velocity, which are suitable for hydrogenation with a
silicalite catalyst, are also suitable for the dehydrogenation
reaction involved in aromatization. Thus, a simple processing
scheme, with only a single reactor stage, is often adequate
both to reduce to a minimal content, or eliminate the olefinic
constituents that would interfere with the economic recovery
of aromatics, and to produce benzene-toluene-xylenes from the
feed stream.

A further important advantage of the invention re-
sides in its ability to process any of a variety of the by-
product effluent streams from pyrolitic cracking processes.
As set out more fully below, these by-product effluent streams
customarily include a C_4 fraction composed predominantly of
butanes, butenes, and butadiene; a C_5 fraction composed mainly
of pentanes, pentenes, pentadienes and cyclic C_5 compounds; a
C_6-C_8 "dripolene" fraction containing BTX aromatics together
with interfering olefins (i.e., having a similar boiling range);

and a C_9-plus fraction, including some BTX along with higher alkylated benzenes and polynuclear aromatics and aliphatics. Each of these streams, plus others that may be present in a particular plant may be processes according to the invention.

The silicalite catalyst of the present invention, to be identified more fully below, is described in Grose et al. U.S. 4,061,724, and its structure is described in an article by Flanigen et al., "Silicalite, a new hydrophobic crystalline silica molecular sieve," _Nature_ 271 512 (9 February 1978). It is a crystalline silica polymorph having identifiable X-ray diffraction characteristics and other properties that have been described in the two references above. An interpretation of the descriptive data is included in an article by Olson et al., "Chemical and physical properties of the ZSM-5 substitutional series," _J. Catal._, 61 (1980). It has been reported that silicalite may exist in two crystallographically distinct forms, termed, "silicalite-1" and "silicalite-2," according to Bibby, "NH_4-tetra-alkyl ammonium system in the synthesis of zeolites," _Nature_, 285, 3-31 (1 May 1980).

Various other aspects of the invention are set out below.

DESCRIPTION OF PREFERRED EMBODIMENTS

1. Pyrolitic Cracking Processes

Pyrolitic cracking processes for the preparation of light olefins and diolefins such as ethylene, propylene, and/or butadiene, have been described in the literature, and accordingly no detailed exposition is called for here.

In essence, the thermal pyrolysis, or cracking, of petroleum fractions may utilize as feed stocks hydrocarbons such as ethane, LPG (liquefiled petroleum gas, chiefly propane with a few percent butanes), naphtha, heavy gas oil, or crude

petroleum oil. These are subjected to controlled high temperature, low pressure, short time, pyrolitic cracking to produce the desired product or products. Thereafter the reactor effluent is subjected to a combination of condensation,

5 fractional distillation, absorption, and perhaps other unit operations, to segregate various effluent streams enriched in one or more desirable components. The precise arrangement of product recovery streams forms no part of the present invention, and indeed it is probable that no two pyrolitic cracking

10 plants utilize the same recovery scheme.

For example, the reactor effluent liquid may be subjected to fractional distillation to separate one or more fractions rich in benzene (B.P. 80.103°C.), toluene (B.P. 110.623°.), and/or the xylenes, namely ethylbenzene (B.P.

15 136.187°C), p-xylene (B.P. 138.348°C.), m-xylene (B.P. 139. 102°C.), and o-xylene (B.P. 144,414°C.). This fraction, or fractions is desirably solvent extracted, as for example by the Udex or Sulfolane process, to recover the BTX aromatic/ aromatics.

20 In the absence of prior treatment, such as by the process of the present invention, solvent extraction is ineffective to extract the aromatics from the remaining aliphatics, inasmuch as solvents selective for aromatics will also extract many olefins and diolefins. However, the diolefins and the

25 aromatics cannot be separated by fractional distillation; for example, benzene, with a boiling point of 80.103°C., is not easily distilled from the 2,4 hexadienes, which boil at about 80.0°C. Similarly, the various dimethylpentenes boil within a range of 72.2°C. to 85.0°C.

30 Be that as it may, and howsoever produced or constituted, there inevitably will be one or more by-product effluent

streams which contain diverse mixtures of hydrocarbon (and perhaps non-hydrocarbon) components, varying both with respect to boiling point and chemical classification. It is this diversity that either complicates or prevents the recovery of

5   useable components.

By way of example, in an illustrative pyrolitic cracking plant, the total reactor effluent may be segregated into a predominantly gaseous fraction including recoverable ethylene and propylene; a crude C_4 fraction, a distillation

10   cut which includes hydrocarbons with primarily four carbon atoms each; a crude C_5 fraction, another distillation cut which primarily contains hydrocarbon molecules with five carbon atoms each, and generally containing a large quantity of unsaturated and cyclic compounds, including olefins and

15   lesser amounts of C_4's and ligher, C_6's and heavier; a C_6-C_8 fraction, sometimes referred to as pyrolysis gasoline or dripolene; and a C_9 plus fraction, a heavier distillation cut which primarily includes hydrocarbons with at least nine carbon atoms, along with lesser amounts of C_5-C_8 hydrocarbons. The

20   C_9 fraction generally is produced as the distillation bottoms from the processing of dripolene to remove pyrolysis gasoline, and contains components as widely varying as styrene, ethyl-toluenes, and trimethylbenzenes to heavier compounds including ethylnaphthalene, diphenyl, and dimethylnaphthalene.

25   An illustrative C_4 fraction, giving both the range and a typical composition, is set out in Table I below:

TABLE I

Illustrative C$_4$'s Composition

Compound	Observed Range	Typical Composition
Lights	0.4-5.0 wt.%	1.1
Methylacetylene, Propadiene	0.1-1.0	0.7
n & i-Butane	2.4-15.0	3.8
1-Butene and Isobutylene	20.0-39.0	33.8
t-2-Butene	4.0-7.0	5.7
c-2-Butene	3.0-5.0	4.5
1,3-Butadiene	41.0-54.0	44.6
Vinylacetylene	0.4-1.5	0.7
Ethylacetylene	0.1-0.5	0.2
C$_{5+}$	0.2-5.0	4.1

Illustrative C$_5$ compositions, from two different plants, "A" and "B," are likewise represented in Table II below:

TABLE II

Illustrative C$_5$'s Compositions

	Plant A		Plant B	
	Observed Range	Typical Composition	Observed Range	Typical Composition
C$_4$ and Lighter	0-1.5 wt.%	0.7	1.4-8.1	5.5
n & i-Pentanes	0.14.4	7.2	17.3-44.60	23.6
C$_5$ Olefins	0.1-11.3	4.6	6.6-37.4	9.9
Pentadienes	9.7-35.3	20.0	3.5-12.9	4.2
Isoprene	2.4-43.0	13.1	5.0-16.8	5.9
Cyclopentane	1.6-7.5	3.2	0-2.0	---
Cyclopentene	2.2-10.3	5.4	2.0-14.4	2.3
Cyclopentadiene	0.60-2.8	1.4	1.0-20.6	4.6
C$_6$ Paraffins	1.1-7.2	4.2	1.3-10.5	10.1

TABLE II (Cont.)

	Plant A		Plant B	
	Observed Range	Typical Composition	Observed Range	Typical Composition
C_6 Olefins	---	---	0.3.0	0.2
Benzene	0.4-5.1	1.3	0-23.8	23.8
Dicyclopentadiene	19.3-48.1	32.1	1.0-21.0	1.8
Other C_{6+}	.1.5-14.8	6.8	0.9.0	8.1

Illustrative C_9 compositions, again from Plant "A" and Plant "B", are described in Table III below:

TABLE III

Illustrative C_9's Compositions

	Plant A		Plant B	
	Observed Range	Typical Composition	Observed Range	Typical Composition
C_5-C_8				
Nonaromatics	0.5-5.4	0.5	0.2-3.4	0.2
BTX	0-9.8	1.7	0-31.9	1.2
Styrene	0.3-10.0	1.8	0.16.8	5.0
Dicyclopenta-diene	7.2-40.0	29.2	4.7-42.0	40.5
Methyl dicyclopentadiene and Dimethyldi-cyclopentadiene	.4.4-21.2	4.4	0-6.5	1.6
Methyl Styrenes	2.3-19.0	6.8	0.15.0	3.6
C_3 Benzenes	8.0-26.0	12.7	0-12.5	7.3
Indane	0.2-16.9	13.8	0-6.9	0.2
Indene	3.9-15.6	9.9	1.0-13.0	9.8
Naphthalenes	0.6-9.3	3.5	3.0-15.0	14.1
Other C_{10+}	10.7-32.6	15.7	14.6-48.6	16.7

It will be appreciated, as noted earlier, that these compositions may vary quite widely, depending upon the initial feed to the pyrolitic cracking unit, the type of pyrolitic cracking unit, conditions in the pyrolitic unit, and the type

5   and conditions of the product recovery section. The by-product effluent streams may likewise be blended with each other where this is desired, or may include recycle components from elsewhere in the product recovery section.

2.   Catalyst

10   The catalyst used in the present process is commonly termed silicalite, a newly discovered crystalline silica polymorph described in Grose et al. U.S. 4,061,724 and in the other references cited previously. It consists of silica, but unlike many of the more common forms of silica, has an open

15   porous structure, with a pore diameter of about 6 Angstrom units, and a pore volume of about 0.18 cc/gram as determined by adsorption. It has a density (as-synthesized) of 1.99 ± 0.05 g/cc. Its refractive index is 1.48 ± 0.01 as synthesized, or 1.39 ± 0.01 after calcining at 600°C. for one hour.

20   The X-ray powder diffraction pattern of silicalite (600°C. calcination in air for one hour) has as its six strongest lines (i.e., interplanar spacings) those set forth in the table below, where "S" is strong, and "VS" is very strong:

TABLE IV

d-A	Relative Intensity
11.1 ± 0.2	VS
10.0 ± 0.2	VS
3.85 ± 0.07	VS
3.82 ± 0.05	S
3.76 ± 0.05	S
3.72 ± 0.05	S

The chemical analysis of silicalite (after 600°C. calcination and washing with 1 N HCl) shows that it consists

of SiO_2, with only insignificant impurities. Alumina, a common impurity, is present to the extent of less than 1 aluminum atom per unit cell of 92 Si atoms. Silicalite exhibits essentially no detectible ion exchange properties, in

5 contrast to the conventional zeolitic molecular sieves.

Silicalite is readily prepared by the procedure of the Grose et al. patent. This involves the hydrothermal crystallization of a reaction mixture comprising water, a source of silica, and an alkylonium compound at a pH of 10 to

10 14 to form a hydrous crystalline precursor, and subsequently calcining that precursor to decompose aklylonium moieties. Thereafter, the calcined precursor is desirably washed to remove any metals or trace contaminants.

When used in the present process, silicalite may be

15 employed either alone or in intimate admixture with independently active catalytic components, as for example the noble metals such as platinum, or other catalytically active metals such as molybdemun, vanadium, zinc, etc. The techniques of introducing catalytically active metals to a molecular sieve

20 zeolite are disclosed in the literature, and with the exception of cation exchange, preexisting metal incorporation techniques are suitable. See, for example, Rabo et al. U.S. 3,236,761 and U.S. 3,236,762.

The physical form of the silicalite catalyst depends

25 on the type of catalytic reactor being employed. Silicalite by itself is a fine-grain granule or powder, and is desirably compacted into a more readily usable form (e.g., larger agglomerates), usually with a silica or alumina binder for fluidized bed reaction, or pills, prills, spheres, extrudates, or other

30 shapes of controlled size to accord adequate catalyst-reactant contact. As indicated, the catalyst may be employed either as

a fluidized catalyst, or in a fixed or moving bed, and in one
or more reaction stages.

3. Conversion Parameters

5   An unusual, if not unique, feature of the present
invention is that the reaction conditions are low severity as
compared with many preexisting processes. Indeed, the conver-
sion parameters, while broad, may be selected to provide a
high degree of versatility, depending upon the feed composition
and on the desired product quality.

10   With respect to temperature, a temperature within
the range of about 300-700°C., more preferably within the
range of about 350-600°C., is adequate for many, if not all,
conversions. Higher temperatures give more rapid and more
complete reaction, but tend to produce undesirable by-products,

15 chiefly coke, and may otherwise disturb the optimum balance of
product composition with on-stream ease of operation.

      The pressure, almost uniquely, is desirably quite
low. Atmospheric pressure operation has been used successfully
in the laboratory, but under specific conditions may be as

20 high as 100 atmospheres or more. A desirable range is from
atmospheric pressure to about 7 atmospheres. High pressures
facilitate hydrogenation; lower pressures facilitate dehydro-
cyclization. The optimum pressure will therefore depend on
process economics, considering whether it is more desirable to

25 hydrogenate olefins than to produce a high yield of BTX aro-
matics.

      Process stream flow rate, as expressed in units of
weight hourly space velocity (WHSV), or weight of hydrocarbon
feed per unit weight of catalyst, is suitably within the range

30 of about 0.1 to about 20, more desirably about 0.5-5.0. High
WHSV's permit more economic plant construction, while lower

WHSV's permit more complete reaction at given temperature-pressure conditions.

If desired, a gaseous or gasifiable diluent may be introduced along with the hydrocarbon feed to the silicalite catalyst. This diluent may be inert, typified by steam, nitrogen or a low boiling paraffin, or may be reactive with the feed under catalysis conditions (e.g., hydrogen). Hydrogen is particularly desirable as it minimizes coke formation and deposition on the catalyst, with resulting premature deactivation, and also facilitates hydrogenation. As demonstrated below, however, the technique of the present invention need not utilize hydrogen.

If either an inert or a reactive gas is employed, diluent/hydrocarbon molar (gas volume) ratios, optimally, of from 0.1 to about 10 may be employed.

It is usually necessary that the catalyst be regenerated, either periodically or continuously, to remove the carbonaceous coke-like deposits from the catalyst. In a fluidized bed operation, a portion of the catalyst is continuously withdrawn from the reactor and then subjected to regeneration by combustion with air or other oxygen containing gas, after which it is continuously recycled to the reactor. In a moving bed operation, the removal of catalyst followed by regeneration may be effected either continuously or periodically. In a fixed bed operation, it is generally desirable that two or more reactors be used in parallel, so that when one is processing the hydrocarbon feed, the other is out of service and being regenerated. Regeneration conditions of approximately 450-650°C., preferably 500-600°C. may be employed.

4.   Example

A specific example of the present invention is pre-
sented below. From the data, it is apparent that olefins and
diolefins are converted by hydrogenation; that acyclic and
cyclic nonaromatic components are dehydrocyclized to aromatic
compounds; that C_9 plus alkybenzenes, indan, indene, and
methylstyrenes are converted in substantial part to the more
desirable C_6-C_8 aromatics; and that, apparently, higher alkyl-
naphthalenes are converted by hydrogenolysis to recoverable
naphthalene and methyl naphthalenes. Additionally, it is
likely that the organic sulfur and nitrogen contents are lowered.

In the example herein, a C_9 plus by-product hydro-
carbon effluent from the thermal pyrolysis unit was reacted
over 37g of 1/16 inch extrudates of silicalite with a 20%
alumina binder. The reaction vessel was a 3/4 inch OD stain-
less steel tubular reactor.

The reaction pressure was ambient; the reaction
temperature was approximately 503°C.; and the space velocity
of the feed varied from 0.57-0.69 g/feed/g catalyst/hr.

Samples of the liquid products, trapped in an ice
water condenser, were taken after one hour and after six hours
on stream. Five gas product samples were taken periodically.

The feed had the following analysis:

Analysis of C_{9+} Hydrocarbon Feed

Compounds	Weight Percent
C_5-C_8 Nonaromatics	0.19
Benzene	0.31
Toluene	0.10
Ethylbenzene, Mixed Xylenes	0.80
Dicyclopentadiene, Styrene	45.46

Analysis of C_{9+} Hydrocarbon Feed (Cont.)

Compounds	Weight Percent
C_9 Alkylbenzenes, Methylstyrenes	10.61
Indan	0.21
Indene	9.83
Naphthalene	12.67
Methylnaphthalenes	1.45
Other C_{9+} Hydrocarbons	18.37

The gas samples were analyzed on a Hewlett Packard 5830A gas chromatograph equipped with a thermal conductivity detector. A forty foot stainless steel column with an OD of 1/8 inch packed with 20% tributylphosphate on 35/80 mesh Chromasorb P (acid washed), was used. The thermal conductivity detector temperature was set at 250°C., and the column temperature was ambient (approximately 20-22°C.). Gas samples were injected into the column off-line, through an eight port gas switching valve, via a gas syringe. The sample gas volume was approximately 0.3cc; the carrier gas rate was 30cc/min of helium.

Liquid samples for both product and feed were analyzed on a Hewett Packard 5730A gas chromatograph, using a 5705A thermal conductivity detector. A ten foot stainless steel column with an OD of 1/8 inch, packed with 15% Carbowax 20M on 40/60 mesh Chromasorb P acid wash, was used. The detector temperature was set at 250°C. The column was maintained in an oven, with a temperature programmed form 55°C. to 190°C. at 4°C./min; the injector temperature was 250°C. A sample size of approximately 2 ml. was used, and the helium carrier gas rate was 30 cc/min.

The following yields were determined:

Product Analysis From Conversion of C$_{9+}$ Hydrocarbons Using Silicalite

		Product Composition (Weight Percent Yield)	
	Compounds	1 hr.	6 hr.
5			
	Methane	3.60	0.87
	Ethane, Ethylene	3.12	1.38
	Propane	5.52	1.12
	Propylene	1.41	0.59
10	C$_4$'s	6.81	3.78
	C$_5$ to C$_8$ Nonaromatics	1.89	8.22
	Benzene	16.44	11.09
	Toluene	19.73	14.08
	Mixed Xylenes	14.56	14.41
15	C$_{9+}$ Hydrocarbons	34.58	58.42

Thus it is apparent that there has been provided, according to the invention, a process that is uniquely effective in treating by-product effluent streams from pyrolytic cracking processes.

20   References

        Mobil Oil U.S. Patent 3,442,795
        Mobil Oil U.S. Patent 3,702,886
        Mobil Oil U.S. Patent 3,728,408
        Mobil Oil U.S. Patent 3,760,024
        Mobil Oil U.S. Patent 3,790,471
        Mobil Oil U.S. Patent 3,813,330
        Mobil Oil U.S. Patent 3,970,544
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B.P. Belg. Patent 862,051

<u>C L A I M S:</u>   **0093475**

1. A low severity process for the preparation of a
benzene-toluene-xylenes containing stream having a minimal ·
monoolefin and diolefin content, from a feed stream comprising
a by-product effluent of a process for the pyrolitic cracking
of hydrocarbons to produce light olefins or diolefins, said
by-product effluent stream containing olefins and diolefins,
said process comprising contacting said by-product effluent
stream, under low severity conditions including a temperature
within the range of about 300-700°C., a pressure within the
range of about 0 to 100 atmospheres, and a weight hourly space
velocity within the range of about 0.1 to about 20, with a
catalyst essentially comprising silicalite, said silicalite
being a crystalline silica polymorph having as the six strongest
d-values of its X-ray powder diffraction pattern those set
forth in Table IV.

2. Process of claim 1 wherein said conditions in-
clude a temperature within the range of about 350-600°C., a
pressure within the range of about 1-7 atmospheres, and a
weight hourly space velocity within the range of about 0.5-5.0.

3. Process of claim 1 wherein said by-product efflu-
ent comprises a C_4 stream.

4. Process of claim 1 wherein said by-product efflu-
ent comprises a C_5 stream.

5. Process of claim 1 wherein said by-product efflu-
ent comprises a whole or fractionated dripolene stream.

6. Process of claim 1 wherein said feed stream is
admixed with a diluent.

7. Process of claim 6 wherein said diluent is
steam.

8. Process of claim 6 wherein said diluent is
hydrogen.

0093475

9.   Process of claim 6 wherein said diluent is a low boiling paraffin.

10.   Process of claim 6 wherein said diluent is a mixture of a low boiling paraffin, hydrogen and/or steam.

	DOCUMENTS CONSIDERED TO BE RELEVANT		EP 83200610.0

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
D,A	US - A - 4 097 367 (HAAG et al.) * Claims; column 3, line 6 - column 14, line 5 * --	1,2	C 10 G 35/06 C 10 G 45/68
D,A	US - A - 4 061 724 (GROSE et al.) * Claims; column 1, line 46 - column 5, line 10 * --	1	
D,A	NATURE, vol. 271, February 9, 1978, London E.M. FLANIGEN et al. "Silicate, a new hydrophobic crystalline silica molecular siere" pages 512-516 * Fig. 1-4 * ----		

TECHNICAL FIELDS SEARCHED (Int. Cl. ³)
C 10 G 35/00 C 10 G 45/00 C 10 G 49/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	01-08-1983	STOCKLMAYER